Claims

[c1] A nuclear magnetic resonance instrument, comprising:
a housing adapted to move in a wellbore drilled through earth formations;
a magnet disposed in the housing adapted to induce a static magnetic field having a selected magnetic field strength in a zone of interest;
an antenna assembly disposed in the housing, the antenna assembly adapted to resonate at a first frequency and a second frequency, the first frequency corresponding to a resonance frequency of a first nucleus at the selected magnetic field strength, the second frequency corresponding to a resonance frequency of a second nucleus at the selected magnetic field strength, wherein the first nucleus is different from the second nucleus;
means for inducing a radio frequency magnetic field according to a selected pulse sequence in the zone of interest, the means for inducing the radio frequency magnetic field being operatively coupled to the antenna assembly; and
means for detecting nuclear magnetic resonance signals at the first frequency, the means for detecting being operatively coupled to the antenna assembly.

[c2] The instrument of claim 1, wherein the first nucleus is a proton.

[c3] The instrument of claim 1, wherein the second nucleus is carbon-13.

[c4] The instrument of claim 1, wherein the second nucleus is oxygen-17.

[c5] The instrument of claim 1, wherein the second nucleus is phosphorus-31.

[c6] The instrument of claim 1, wherein the zone of interest is in the earth formations surrounding the wellbore.

[c7] The instrument of claim 6, wherein the housing is adapted to be lowered into the wellbore on an electric cable.

[c8] The instrument of claim 6, wherein the housing forms part of a drilling tool assembly.

[c9]

The instrument of claim 1, wherein the housing forms part of a formation fluid

sampling tool and the zone of interest is inside the formation fluid sampling tool.

[c10] The instrument of claim 1, wherein the antenna assembly comprises an antenna coupled to a double resonance circuit.

[c11] The instrument of claim 1, wherein the antenna assembly comprises a first antenna and a second antenna.

[c12] The instrument of claim 10, wherein the first antenna and the second antenna are substantially orthogonal to each other.

[c13] The instrument of claim 10, wherein at least one of the first antenna and the second antenna comprises one selected from a saddle antenna and a loop antenna.

[c14] The instrument of claim 10, wherein the first antenna is selectively connected to a circuit adapted to transmit a radio frequency wave having the first frequency and the second antenna is selectively connected to a circuit adapted to transmit a radio frequency wave having the second frequency.

[c15] The instrument of claim 1, wherein the selected pulse sequence comprises a Carr-Purcell-Meiboom-Gill pulse sequence at the first frequency and an 180-degree pulse train at the second frequency.

[c16]

A nuclear magnetic resonance instrument, comprising:
a housing adapted to move in a wellbore drilled through earth formations;
a magnet disposed in the housing adapted to induce a static magnetic field having a selected magnetic field strength in a zone of interest;
means for inducing a radio frequency magnetic field in the zone of interest at a first frequency, the first frequency being a resonance frequency of a first nucleus at the selected magnetic field strength;
means for inducing a radio frequency magnetic field in the zone of interest at a second frequency, the second frequency being a resonance frequency of a second nucleus at the selected magnetic field strength, wherein the first nucleus is different from the second nucleus; and

means for detecting nuclear magnetic resonance signals at the first frequency.

[c17] The instrument of claim 16, wherein the zone of interest is in the earth formations surrounding the wellbore.

[c18] The instrument of claim 16, wherein the housing forms part of a formation fluid sampling tool and the zone of interest is inside the formation fluid sampling tool.

[c19] A nuclear magnetic resonance instrument, comprising:
a housing adapted to move in a wellbore drilled through earth formations;
a magnet disposed in the housing adapted to induce a static magnetic field having a selected magnetic field strength in a zone of interest;
an antenna disposed in the housing, the antenna being adapted to resonate at a frequency corresponding to a resonance frequency of a nucleus at the selected magnetic field strength, wherein the nucleus is not a proton;
means for producing a polarization transfer pulse sequence and a Carr-Purcell-Meiboom-Gill pulse sequence, the means for producing being operatively coupled to the antenna; and
means for detecting nuclear magnetic resonance signals.

[c20] The instrument of claim 19, wherein the zone of interest is in the earth formations surrounding the wellbore.

[c21] The instrument of claim 19, wherein the housing is part of a formation fluid sampling tool and the zone of interest is inside the formation fluid sampling tool.

[c22] A method for determining a formation fluid property using a nuclear magnetic resonance instrument in a wellbore, comprising:
inducing a static magnetic field having a selected magnetic field strength in a formation fluid sample;
acquiring nuclear magnetic resonance measurements having J coupling information using the nuclear magnetic resonance instrument; and
deriving the J coupling information from the nuclear magnetic resonance measurements.

[c23] The method of claim 22, wherein the formation fluid sample comprises connate fluids withdrawn into a sample tube of the nuclear magnetic resonance instrument in a formation fluid sampling tool.

[c24] The method of claim 22, wherein the formation fluid sample comprises connate fluids in earth formations surrounding the wellbore.

[c25] The method of claim 22 wherein the acquiring comprises collecting nuclear magnetic resonance data using a pulse sequence that includes a Carr-Purcell-Meiboom-Gill pulse sequence.

[c26] The method of claim 22 wherein the acquiring comprises collecting nuclear magnetic resonance data using a pulse sequence that includes a phase-cycled Carr-Purcell-Meiboom-Gill pulse sequence.

[c27] The method of claim 22, wherein the J coupling comprises homonuclear J coupling.

[c28] The method of claim 22, wherein the J coupling comprises heteronuclear J coupling.

[c29] The method of claim 28, wherein the acquiring comprises
(a) applying an excitation pulse at a first frequency, the first frequency being a resonance frequency of a first nucleus at the selected magnetic field strength;
(b) waiting for a selected delay time;
(c) simultaneously applying a refocusing pulse at the first frequency and a inversion pulse at a second frequency, the second frequency being a resonance frequency of a second nucleus at the selected magnetic field strength, the first nucleus being different from the second nucleus;
(d) waiting for the selected delay time; and
(e) recording signals at the first frequency.

[c30] The method of claim 22, wherein the recording lasts for a duration shorter than the selected delay time.

[c31] The method of claim 23, further comprising:
repeating, for a predetermined number of times, (c) through (e) after a duration

that substantially equals the selected delay time has elapsed since start of the recording.

[c32] The method of claim 22, wherein at least one of the excitation pulses, the refocusing pulse at the first frequency, and the inversion pulse at the second frequency comprises a composite pulse.

[c33] The method of claim 22, wherein the acquiring comprises collecting nuclear magnetic resonance data using a reverse-detection pulse sequence.

[c34] The method of claim 33, wherein the reverse-detection pulse sequence further comprises a polarization transfer pulse sequence.

[c35] The method of claim 22, wherein the acquiring comprises using a pulse sequence comprising one selected from an inversion-recovery pulse sequence and a saturation-recovery pulse sequence.

[c36] The method of claim 22, wherein the deriving comprises separating a J coupling modulated part from an unmodulated part in the nuclear magnetic resonance measurements.

[c37] The method of claim 36, wherein the separating is performed with Fourier transformation.

[c38] The method of claim 22, wherein the deriving comprises obtaining a difference measurement.

[c39] The method of claim 22, further comprising estimating a formation fluid property from the J coupling information.

[c40] The method of claim 39, wherein the estimating further comprises using, in combination with the J coupling information, at least one parameter selected from a spin-lattice relaxation time, a spin-spin relaxation time, a ratio of spin-lattice relaxation time and spin-spin relaxation time, and a diffusion constant.

[c41] The method of claim 39, wherein the estimating further comprises using, in combination with the J coupling information, at least one parameter selected from compositional information, optical properties, mechanical properties,

electrical properties, and nuclear magnetic resonance properties.

[c42] A method for estimating a volume fraction of oils in earth formation fluids, comprising:
acquiring nuclear magnetic resonance measurements having carbon-hydrogen J coupling information;
separating a J coupling modulated part from an unmodulated part in the nuclear magnetic resonance measurements; and
determining the volume fraction of oils in the earth formation fluids by comparing a total magnitude of the J coupling modulated part to a total magnitude of the nuclear magnetic resonance measurements.